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# CREATIVE APPROACH TO COMPUTING THROUGH MUSIC IN THE EARLY CHILDHOOD EDUCATION

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**Abstract:**
This paper applies an experimental case study aiming at the assessment of the effectiveness of computer science teaching, when it is framed by activities with clear direction of "creation and expression" and in particular music. The research goes beyond the view that computers are a tool and examines them as a subject of the curriculum of the kindergarten through a creative didactic intervention. The sample was divided into two groups, the experimental group that implemented a training program for teaching basic computer concepts supported by alternative creative musical education activities and the control group which implemented a corresponding program that utilized "tutorials" and "drill and practice" software. The analysis of the data shows that computer literacy combined with music education activities had improved learning outcomes compared to the method used by guided teaching through software. The research supports the proposal for the development of educational approaches to computer science, which escapes from the narrow contexts of interaction with the PC, and is accompanied by alternative activities and adapted, as well to the particularities and characteristics of early childhood.

**Keywords:** early childhood, education, educators, digital pedagogy, creative didactics, music, informatics, technology, computer in preschool education

## 1. Introduction

Pre-school education is the stage where there has been and still exists a strong concern about the technology integration (Nikolopoulou & Gialamas, 2013). In general, though

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it appears that proper integration of new technologies in pre-school education can reinforce almost all areas and subjects of learning (Brooker & Siraj-Blatchford, 2002; Plowman & Stephen, 2003) a key role to overcome the skepticism about technology integration plays the potential of computers that, by appropriate exploitation, can establish them as an important learning tool (Anderson et al., 2008; Clements & Sarama, 2003; Hutinger et al., 2006; Jonassen & Reeves, 1995; McCarrick & Li, 2007; Siraj-Blatchford & Siraj-Blatchford, 2006). Different surveys, on the one hand, support the view that computer use in kindergarten (independently) is not effective, taking into account the fact that non-computer activities improve children's learning outcomes (Clements, 2002; Morgado, 2008; Ntoliopoulou, 2000). Others also support the view that the ability of children to use computers depends to a large extent on appropriate teaching practices (Baron & Harrari, 2005; Kalogiannakis, 2010). Seeking to contribute to the enrichment of data related to computer science teaching at preschool children, we focus on experimental educational intervention supported by alternative creative music activities which aim to teach basic concepts of computing. By approaching the specific research as an experimental case study, the results of our intervention are compared with those resulting from the application of a more common method of guided teaching with the support of a relevant software.

We chose to exploit activities from the field of music because all children have musical abilities that can develop from early childhood (Chen-Hafteck, L., 2004; Read & MacFarlane, 2006). In addition, it is becoming increasingly clear that all human beings are biologically predisposed to music and that this inherent predisposition to musicality has significant consequences to children of this age (Hodges, 2000; Imberty, 2000; Trehub, 2000). The musical stimuli are scattered in everyday life of children (Gillen et al., 2007), especially with the spread of new technologies in their everyday lives (Young, 2008). Children's engagement to music activates an important learning area of the brain (McKinnon, 2005), while it has shown that musical stimuli in general is an extremely qualitative experience for the development of children (Addessi et al. 2006; Csikzsentmihalyi, 1990; Miyamoto, 2007; St John, 2006). At the same time, by pursuing to enhance the interest and participation of children in their computer engagement, the method of developing intertextuality (Kumpulainena, Vasamaa, & Kangassalo, 2003) is being applied, reframing computer activities with personal identifying information and heroes' roles through a story that is being told to the children. Moreover, replenishing the activities of children of this age with alternative activities beyond screen interactivity makes technology integration more effective (Clements, 2002; Takeuchi 2011).

## 2. Methodology

The survey was conducted in 3 kindergartens, of which two in the urban area of Thessaloniki and one in a rural area, in a neighboring county, during February-March 2015 and January-February 2014, respectively. The sample consisted of 52 preschool children, aged 3.5 to 5.5 years, of whom 25 were boys and 27 were girls. For the purposes of the survey, the children were divided into two equal groups, which we sought to be equivalent at the level of learning abilities. Equal segregation of the groups was considered by the early childhood educator according to the criteria of the general active participation and performance of the children in the nursery education process. In the 1st, the experimental group implemented a program of educational intervention to teach basic concepts of information technology supported by alternative creative activities, mainly music, which are described in detail below. In the 2nd, the control group implemented a corresponding training program that utilized relevant widespread guided teaching software, namely, from the RamKid series, entitled "Pipis the Computer and its Friends", in Greek. With this software, the children, assisted by the teacher, were motivated to interact with the computer in small groups of two or three and in rotation, everyone did participate. The kindergarten teacher motivated children, by creating a playful environment, to participate. This software was chosen to be used by the control team because it is widespread in preschool education and it was a well-established practice of initiating infants in the use of computers that had prevailed in this area from the past.

Both groups were given the same time frame (4 weeks of 3 hours a week). The didactic interventions were carried out with the classroom desktop computer as well as a laptop computer provided by each early childhood educator. For the collection of research data, participatory observation was used in the classroom where the observer was involved in the activity in order to contribute to the completion of the process. Also, a knowledge assessment test was applied concerning the basic concepts of the computer, before and after, to each of the two groups by the teacher. Children's paintings as well as recording and transcribing the dialogues for further analysis were also exploited. The assessment test evaluates children on a 5th conventional scale and relates to knowledge and skills that have been detected: a) by using evaluation sheet with matches b) through a practical test at the computer using modules of the GCompris educational software suite and (c) through discussion with children. These data were evaluated by the teacher, which had previously been trained for this process, and had special assessment rubrics available. In order to make a comparison between the two groups, a conventional rating scale from 1 to 5 was adopted, which resulted from the adaptation of children's performance to the above detection tools. The

performance on the 5th conventional scale of the assessment test was applied by the researchers, according to the material that emerged from our research data. The GCompris software suite was used for contractual assessment, at an individual level because it is free playable software with a clear educational orientation and secondly, because it has features exercise games that provide the right framework in order to detect many of the criteria we have set regarding the usage skills that have been evaluated (it has levels of difficulty, time & number of mistakes, etc.). The GCompris was used to trace skills (4), (5), (6), (7), (8), (10) (see Table 2).

The purpose of the research was to study the design, implementation and results of an educational intervention. More specifically, we seek to examine the didactic approach that is framed alternatively with creative music activities, beyond computer interaction: (A) if it has an improved learning outcome in relation to the application of guided teaching software, (B) if it is appealing to children and gains participation, as well as helping them to communicate and co-operate, and (C) attempts to clarify the way in which this educational intervention is implemented in real-world classroom conditions.

It is noted that the children were familiar with musical activities since a music education program has been in place since the beginning of the school year. In order to replenish the alternative experimental intervention, the computer has been personalized, given an identity, an attractive face, and a fantastic role, as part of a theatrical play. The method of "intertextuality" was applied in order to strengthen the positive attitude of the children towards the activity and encourage their participation.

Replenishment was attempted through a properly designed role-playing experience, where a letter that came to the classroom of the Kindergarten by Mrs. "Music", which wanted to recommend to children a very good friend, the Mr. "Computer". Thus, through a poem-riddle that we devised and which was melodic, started the conversation with the children about the computer and how it works, what it consists of and what it serves us. Educational intervention in the experimental group is summarized in Table 1.

**Table 1:** Concise description of Intervention in the Experimental Group

| **Activities** | **Description** |
|---|---|
| Personification of the computer is attempted. Musicalization "event". | Children are involved in a musical history with their participation in it while there is a piano accompaniment. "*The lady music, presents us her boyfriend, the computer*" *"A friend I have good / smart, fashionable, creative. / With him when I play / in the* |

| | |
|---|---|
| | *music of the world I travel / I hear, I learn, I paint / the musical instruments with him I know!"*, Do you guess who it is? |
| Detection of pre-existing knowledge - Discussion | Histogram development, exploitation of pre-existing knowledge and experience. (Off-screen activity)<br>Create Histogram, Flow: What is it? How does it work; What are its parts? What does it serves us? Can He Do Us Good or Bad? What should we take care of? |
| Depiction of event | Painting on paper with theme picture Mrs. Music and Mr. Computer |
| Discovering the computer via music | Matching computer components to percussion instruments of the class:<br>Keyboard to woodblocks (rhythm 5/4), System Unit to castanets (rhythm 1 & 1/4), Monitor to timbales (rhythm 3 * 1/2), Printer to cowbells (rhythm 4/8), Mouse to tambourines (rhythm 1/4 & 1/2) |
| Rhythm games with rhythmic patterns<br>Keyword - Concepts from the field of Informatics | Rhythm games with rhythmic patterns of each word. At first, children play the above rhythmic motifs of each word: (a) with their bodies (clapping, knees etc.), (b) with the percussive musical instruments (each child picks a musical instrument) |
| Music and movement activity: matching the correct meaning | There are pictures of the parts of the computer in the classroom and the children each time they hear the corresponding musical instrument and pattern (see example), they run to catch the corresponding picture – computer part (the musical instruments played by the teacher or a child ) |
| Music and movement activity: recognition and imitation-(pantomime) | By listening to the above combination of musical instrument-patterns, children mimic with movements that it has been previously agreed and represent the function of the "computer concept" (for example, to the keyboard they mimic that they write with their hands on their knees, to the tower that they think, etc.) |
| Modeling - Stimulating event | Following the above activities, the story continues with music composition, and children are invited to participate in the song<br>"*The computer got sick ... / And the doctor told him strictly ... / Relax! And not a lot of work! ... / Only play and joy! ... / So you will be good again!! / And so Music / her friend helps without much thought! / Will we all help it together?" ....* »<br>(rhyme exists in Greek) |
| Game with models of tone color & rhythmic patterns | (a) Groups of two children use the computer, where each child presses a different button (e.g. 1 and 8) corresponding to a different instrumental sound and rhythm. Then children print the "sound-score" they created in Word and interpret it with the musical instruments.<br>(b) The children in groups of two, repeat according to the previous |

| | |
|---|---|
| | activity, where each child presses a different button corresponding to letters (instead of numbers), the "-" button in pause and the "space" key in the extended silence. Accordingly, they print their sound and interpret it with musical instruments. |
| Search the Internet and become familiar with the computer handling symbols | With the support of the educator, kids are looking for an already popular childish song of their choice in the Internet (YouTube). All children participate as a choir, while the role of the conductor plays the child who handles the computer. Using the "play" and "pause" symbols as well as the volume of the sound, the child using the computer guides the choir, which follows the instructions. All children in rotation play the role of the computer operator- "Maestro-the conductor". |
| Familiarization with the use of the mouse through rhythm and sound | Children learn to play simple musical parts on the glockenspiel and the tambourine. At the same time, they try to play these tunes by using software-simulations of children's musical instruments (using software GCompris & poissonrouge). Then children separated in groups of two try to synchronize while playing the "tangible" musical instrument and the instrument simulated on the computer. |
| Painting with the computer | Using the TuxPaint software, children represent the musical "The Lady Music and the Friend of the Computer". |

## 3. Results and Discussion

The test scores applied to the children of both groups showed the results reported in Table 2. The data resulted from the assessment sheet of the concepts (matching tests), the discussion with questions conducted by the educator and children's interaction with some software applications (GCompris). The researchers evaluated the children at the 5th scale evaluation assessment tool, which resulted from the adaptation of the above data and represented a conventional performance score that corresponded to specific skills and knowledge about computer use. We believe that the lack of weighted evaluation test does not affect our research findings, as the results of the comparative assessment are compared between the children participating in the experiment and it is noted that they do not represent weighted indicators. In order to compare performance both before and after the interventions of both the experimental group and the control group, we applied the non-parametric test (Wilcoxon test) as the conditions for applying the relevant parametric criteria were not met, as in the present study the sample is small ($n < 60$) and no normal distribution is found.

The results show that the difference in performance in the experimental group is distinct and is supported by indicators of statistical significance. Particularly strong is

the improvement of children's recognition of the concepts of PC components, their ability to activate and "shut down" computer, detect and distinguish section of the keyboard, skillfully use the mouse, insert the CD to player and start it and give a command to print. There is no difference in improving the ability to distinguish right and left mouse clicks. More generally, however, it emerges from the research evidence that the enriched educational intervention in the experimental group, combined with creative musical activities, has distinctly improved the learning outcomes of the children in the field of computer science. Improvement is also observed in the group of students (control group) in which children have used relevant guided teaching software (RamKid). However, we observe that the degree of development is not on the level of improvement achieved by the experimental group and on the other hand, it is not supported by an equivalent level of statistical power. The teaching method through guided teaching software, comparing both overall learning outcomes and the individual skills, the image of its effectiveness seems to be weakened in relation to the results of the children of the experimental group.

| | **Experimental Group** | | | **Control Group** | | |
|---|---|---|---|---|---|---|
| **Abilities** | **Before M.O.** | **After M.O** | **Comparison Z/p*** | **Before M.O.** | **After M.O.** | **Comparison Z/p*** |
| (1) They discern the meanings: mouse, click, Enter key, keyboard, monitor, speakers, microphone, printer, camera, cd-player | 2,38 | 4,13 | -2,38/,017 | 2,75 | 3,50 | -2,12/,034 |
| (2) They are able to turn on and off the computer | 2,38 | 4,25 | -2,26/,024 | 2,38 | 3,13 | -1,89/,059 |
| (3) They distinguish the sections of the keyboard (numbers, letter keys, enter, arrow keys, and spaces) | 2,63 | 4,38 | -2,56/,010 | 2,75 | 3,25 | -1,26/,200 |
| (4) They are able to move the cursor using the arrows keys | 3,13 | 4,25 | -2,25/,024 | 3,25 | 4,25 | -2,27/,023 |
| (5) They are able to use the mouse skillfully | 2,75 | 4,25 | -2,40/,016 | 3,25 | 3,75 | -2,00/,046 |
| (6) Degree in which it manages to coordinate hand and eye movements | 2,25 | 3,38 | -2,25/,024 | 3,00 | 3,50 | -1,41/,167 |
| (7) They are able to do right and left mouse clicks | 2,75 | 3,88 | -2,251/,024 | 3,00 | 3,25 | -1,41/,157 |
| (8) They are able to distinguish the right one from the left mouse click | 2,25 | 2,75 | -1,414/,157 | 2,25 | 2,88 | -1,66/,096 |
| (9) They are able to place and operate an CD on the CD-player. | 2,38 | 4,50 | -2,549/,011 | 2,63 | 3,38 | -1,857/,063 |
| (10) They are able to type specific letters and numbers | 2,63 | 3,75 | -2,251/,024 | 2,63 | 3,50 | -2,070/,038 |

| | | | | | | |
|---|---|---|---|---|---|---|
| (11) They are able to print to the printer | 3,63 | 4,38 | -1,897/,058 | 3,25 | 4,13 | -2,070/,038 |
| *** Wilcoxon test** | | | | | | |

Comparing the performance of the children of the two groups after the intervention, given that approximately equal performance is recorded before the intervention, we find that experimental intervention has resulted in improved learning outcomes both in its overall assessment and in the individual perceptions of PC concepts and abilities. The difference in score is reflected particularly in cases relating to specific knowledge, e.g. to distinguish the concepts of computer components, to distinguish between areas of the keyboard, to place and start a CD, while being weaker in use abilities e.g. the ability to move the cursor with the arrow keys, the ability to co-ordinate between eye and hand, the typing of letters and numbers, skills that also require long-term familiarization. Notable deviation in the above comment is the performance of the experimental group children in mouse control skill, where despite the fact that arose to have lower initial performance, seems to have improved, particularly after the educational intervention. We believe that this is a result that is due to the special training of the experimental group children with mouse in their effort to achieve the rhythm when they tried to play simple musical pieces in instrument simulations on the PC and to synchronize with the musical instrument that played in parallel.

We believe that an important role in the improved performance of the experimental group children was also the successful development of a generally positive attitude by children towards PCs, which is supported by the data listed below. Through the analysis that emerged from the transcription of the interviews with the children of the experimental group, there are characteristic expressions, which are mentioned as follows:

Initially, as far as the detection of the pre-existing knowledge is concerned, there are references such as: "*it is a tablet (the one child), ..... not saying tablets (another child)*", "*Is an electric machine,*" "*it's something we open it up and then we see on screen the things we write on the keyboard,*" "*it's a game," "it's a thing we can see and play,*" "*it's a box that has a TV*". It is found, however, that although the computer is an object recognizable by children, they appear to have confusing perceptions about it. These representations seem to be strengthened and clarified, after completing the intervention as children respond, to a satisfactory degree, to the assessment of knowledge of the relevant concepts.

Both during and after the intervention, characteristic expressions of the children of the experimental group are collected, suggesting a positive attitude towards the computer. Indicatively: "*We will shut off the computer, to sleep ... tired ....*", "*I like to help the computer get better ...*", "*if it's sick then it hurts ..... I do not want to hurt*" "*The main computer is my friend ....*", "*the computer does love the music (a child) ..... will get married (another*

*child)", "He has this as a friend (he means the computer) because it has many songs .... and it sounds loud ....", "Is smart computer ..... music is beautiful .... but they are not people", "Mrs. (their teacher). Shall we wake him up and play? "...can I uncover him (means the protective cover of the computer) ", "Are we going to do things today on the computer?", "Look for information ... and let the computer sing ...", "Such a computer has my mom ... I do not spoil this I care too", "And my dad has for him the computer ...".*

At the same time, the children of the experimental group show to reduce their "distance" from the PC. While, prior to their acquaintance with the computer, children preferred to use the musical instruments with which they were particularly familiar, now with the activities that were developed, it was observed that increasingly the children of the experimental group preferred when sharing roles to be the ones that use the computer. So, in sharing the roles, they express their preference for actions that bring them into contact with the computer as they indicatively mentioned: *"I want to have the mouse (a child) ..... since I did it (another one). .... etc ", "I would like to try again ....".*

Also, as soon as the intervention began, children increasingly brought to the group descriptions of PC-related representations coming from their family environment, something that did not happen to the same extent until then. Respectively, there was no apparent difference in the children's control group. Thus, to the children's experimental group were recorded characteristic expressions that it is now found that they were focused and specific: "*Ours is black .... (it means the CPU unit)", "my uncle listens to music in the shop .....", "we have bigger, taller ... and bigger screen ..... "," my brother, gives it to me to play .... "," our own mouse turns light "," at home we talk with my uncle .... we see him .... (child of a family of foreigners) "*. These are expressions that suggest the enhancement of computer's representation in children, who after their intervention with the computer seem to show increased interest and great responsiveness to stimuli related to the computer.

From the children's computer paintings, as well as from their comments when asked for a description and explanations by the pre-school teacher, the following observations arise:

In their paintings before the intervention, the dominant element was the screen; they included irregular shapes, unconnected with each other. Furthermore, the children's comments on their paintings concerned fragmented knowledge which was lacking in consistency. After the intervention in the paintings of both groups, an improvement is observed. After that, most computer components are relatively discernible, while children's explanations support their knowledge to distinguish computer-related concepts. The main feature of the experimental team's paintings is the children's impression for the musical history that framed the activity and is related to "Mr. Computer as a friend of Mrs. Music". In children's paintings are dominant the

elements of the musical history, as an indication of their strong impact on children. So, we conclude that it was the key element of their participation in the learning process. The drawings, however, clearly contain the details of the computer, while the children in the subsequent discussion were able to clarify the concepts of computer science taught through the experimental intervention.

Regarding the participation and cooperation of children, it is noted that they as a whole were already familiar with team work, as group activity was, from the beginning, the dominant model of action of the school departments we chose. In both groups, there was no problem with the development of team action. Besides, the cooperation of children by groups was necessary because of the existence of a single computer within the group. However, some individual observations are highlighted, mainly concerning the most introvert and reluctant children of the experimental group, where there was a strong increase in their willingness to participate. This positive effect is attributed to the variety and the alternatives of the roles developed in the context of experimental intervention, which did not occur at the same time as to create comparison and competition between children. On the contrary, it gave the opportunity of initiative and importance to the action of each member. It should be noted the great importance that played every single role which is found to be decisive for the outcome of the team's motivation, as well as the alternation of different activities, characterized by tangible uses and mobility, elements that complemented the static nature of computer use. Thus, while the experimental group did not record incidents of disagreement, claim, persistence or dysphoria in cooperation, in the case of the control group given the existence of a single computer for 8 children, such situations were not avoided.

## 4. Conclusions

The integration of computer science in the curriculum of the kindergarten has a dual character as it is treated not only as an "instrument" in the sense of a learning tool but also as a distinct field of the curriculum (Komis, 2005). Usually in the interventions that are undertaken in the kindergarten, the computer is the tool-instrument and supports the activities of the various cognitive objects (Nikolopoulou, 2010). In this research approach, we go beyond computing as an "instrument" and place it at the heart of the kindergarten curriculum as a separate subject. In relation to the principle which perceives the computer as the instrument-cognitive tool that frames the other cognitive objects, we use other cognitive objects, in our case the cognitive object of "creation and expression", thus making them the "means" to teach computer science in kindergarten through music. A criterion for selecting activities from the field of music was that all

children have musical abilities that can develop from early childhood (Chen-Hafteck, L., 2004; Read & MacFarlane, 2006). The aim of our research approach was to examine the effectiveness of computer science teaching when it is augmented by music activities. The analysis of the data suggests that computer literacy combined with music education activities had improved learning outcomes compared to the method used by "tutorials" and "drill and practice" software, while it seemed to encourage children's participation in teaching and to help co-operate with each other.

We believe that our research findings are combined with corresponding findings from the relevant literature and support the proposal to develop educational approaches to information technology in preschool education that escape from the narrow contexts of interaction with the computer and are framed by alternative activities and adapted to the peculiarities and the characteristics of early childhood education (Anderson, 2000; Clements, 2002; Copple & Bredekamp, 2009; Nikolopoulou, 2009; Ntoliopoulou, 2006; Takeuchi 2011; Van Scoter et al., 2001). As a research limit, however, it is noted that the small sample from which the results were obtained does not allow generalization, but mostly contributes as research evidence associated with other corresponding findings. It is necessary to extend the research to the level of interpretation in order to further understand the reason why this is happening, as well as what other fields would help in the enhancement of computer science teaching in the education of pre-school children.

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